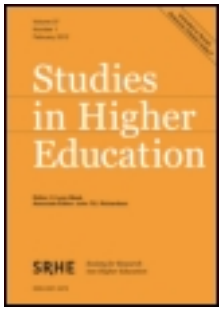

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A creative learning ecosystem, quality of education and innovative capacity: a perspective from higher education

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A creative learning ecosystem, quality of education and innovative capacity: a perspective from higher education

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Globally, governments recognize the importance of creativity and innovation for sustainable socioeconomic development, and many invest resources to develop learning environments that foster these capacities. This paper provides a systematic framework based on Nair's *Innovation Helix* model for studying the factors of a country's creative learning ecosystem (CLE), the quality of its education system (QES), and its innovative capacity (IC). The CLE factors are *infrastructure/infostructure* (physical and digital infrastructure), *intellectual capital*, *interaction*, *integrity systems*, *incentives*, and *institutions*. Using a composite CLE index for 113 countries, the findings indicate a strong correlation between a country's CLE, QES and IC. Through brief case studies of countries that measure highly in CLE, QES and IC, this study points out their higher education strategies and their best practices for other countries to emulate, in order to facilitate creativity and innovation through higher education.

Keywords: creative learning environment; knowledge society; higher education; innovation

Introduction

The rapid technological developments over the last three decades that are inherent in the knowledge society have changed the way people learn and share information globally, with the result that information and knowledge are accessible with the click of a button. In this world of rapid change and to maintain and extend their level of progress, several studies have shown that nations require a workforce that has the capacity for creative thinking. This enables them to take advantage of the availability of knowledge and subsequently devise innovative solutions to challenges encountered by various segments of society. Indeed, the varying levels of creative talent and skilled workforce have been linked to income disparities across countries (Lucas 1988; Hagopian and Lee 2012). Specifically, lack of creative talent due to massive 'brain drain' and weak educational systems in many developing and under-developed countries have hindered their innovative capacity and wealth creation. On the other hand, countries that can increase their supply of creative workers improve their economic growth and competitiveness (Romer 1990).

Many developing and under-developed countries have abundant natural resources, and governments in these countries recognize the importance of a sound education

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system to ensure effective and sustainable use of their natural resources. For example, the Malaysian government invests significant resources to upgrade the education system and sees it as an important catalyst for improving economic wellbeing of all segments of the population. Education policies have been developed to ensure that the training and skills provided meet the needs of Malaysia's economy as it transitions from production-based to innovation-intensive (Nair 2011). As part of this t-ransformation, a number of strategic plans have been introduced to enhance the quality of education and the creative talent of students in Malaysia. This includes the 2007 National Higher Education Action Plan that aimed to develop high quality post-secondary education in Malaysia to contribute to a sound foundation for an innovation-driven society and high-income economy (Ministry of Higher Education, Malaysia 2007).

In many of the developed countries, education continues to receive high priority in national development plans, as it is seen as an important driver for national competitiveness. For example, the recent Australian review of higher education (Bradley et al. 2008) emphasized the importance of quality higher education as contributing to a workforce that will enable Australia to compete effectively in the new global economy.

But while a country's education system has a vital role to play in the development of creative thinking, the education system is underpinned by a web of societal resources, which may be termed a creative learning ecosystem (CLE). These resources include 'infrastructure/infostructure 'of physical and electronic resources for speedy and cost-effective transfer of knowledge between all stakeholders; 'intellectual capital' development programs and innovative teaching pedagogies to foster creative thinking; 'interaction' between parties involved in developing creative ideas; 'integrity systems' to outline and continuously support compliance with best global practices and quality assurance; the 'incentives' available to encourage the development of creative thinking; and finally 'institutions' as the established systems of social rules and norms that structure social interactions (Hodgson 2006).

All of these resources operate together and holistically, to produce a CLE which shapes the quality of the education system (QES) and in turn fosters innovative capacity (IC) in students. An example of this relationship is the situation where low student enrolments and high dropout rates in primary school in developing countries can be attributed *not only* to the cost of education, but to the lack of educational institutions *and* the lack of infrastructure/infostructure that provides access of marginalized communities to the education resources (United Nations 2011). This means students are denied opportunities for interaction, intellectual development and tools that enable creative learning.

This study of 113 developed and developing countries shows a high correlation between the level of development of a country's CLE, its QES and its IC. The findings are that countries with highly developed CLE score highly in QES and also in IC. Conversely, countries with weak CLEs perform poorly in QES and IC. While all education sectors are important, this paper considers higher education as pivotal to a country's socioeconomic development, and provides best practice in higher education from countries that are ranked highly in QES. Key features of the education systems and initiatives undertaken to continuously upgrade the QES in these countries are discussed. These provide valuable insights for other developing countries that are restructuring their education systems.

Background: creativity and the knowledge society

Creativity, leading to the development of new knowledge and innovation, is integral to the knowledge society. As the outcome of 'complex interactions between technical, social, economic and human factors' (Tuomi 2005, 4), the knowledge society enables the creation of economic and social capital. The earlier information society focused on gathering and collating information (European Foundation for the Improvement of Living and Working Conditions 2004), whereas the knowledge society employs creative thinking to transform and make such information useful (Resnick 2007, 1; Ferrari, Cachia, and Punie 2009, iii). This requires technological development so that people can readily access information and knowledge (Nair 2011) and devise innovative responses to emerging issues. In turn, these fuel national economic development and improvement in social wellbeing (David and Foray 2002).

While the literature provides a range of explanations of creativity, a common strand that underpins these diverse views is that creativity can be developed through education and is not the domain only of gifted individuals (Lin 2011; Dyer, Gregersen, and Christensen 2009). Drawing on the characteristics of creativity outlined below, a higher education system to develop creative capacity involves problem solving and higher level thinking processes, rather than rote learning and recycling of information. For example, being creative means thinking differently, or combining existing ideas, images or expertise in original ways (Association of American Colleges and Universities 2011). Creativity entails using both convergent and divergent thinking (Belliugi 2009, 700) and in seeing possibilities not noticed by others (Craft 2005, as cited in Ferrari, Cachia, and Punie 2009). It is entwined with critical thinking, comparing, contrasting and making assessments.

Innovation emerges from creative thinking, as evident in solutions to problems (European Foundation for the Improvement of Living and Working Conditions 2004). While there are diverse definitions of innovation, this study adopts McFadzean's (1998) perspective, that it is characterized by new or significantly improved products (goods or services), processes, new marketing methods, or new business practices (McFadzean, citing Newell, Shaw, and Simon 1958). In line with McFadzean's view, this study captures innovation (as seen in Appendix 1) according to a country's level of innovative capacity, measured by enterprises developing their own technology or by using that of foreign companies.

This study shows that increased diffusion of innovation and knowledge globally has enabled smaller countries such as Switzerland, Finland, Singapore and Sweden to develop CLEs that foster creativity, and lead to the next generation of innovations and new sources of economic growth. Furthermore, more agile and resilient education systems powered by CLEs in these countries have enabled them to surpass traditional economic superpowers in economic development and competitiveness.

A conceptual framework for an innovation driven society

This study utilizes the integrated framework of the CLE which is based on the *Innovation-Helix* model proposed in Nair (2007, 2011), as shown in Figure 1. The framework outlines the resources that, working together, underpin the development of a QES in a country, which fosters creative thinking, leading to innovation. However, for a QES, there needs to be congruency in levels of development across the CLE resources. In the context of education, highly developed infrastructure/infostructure

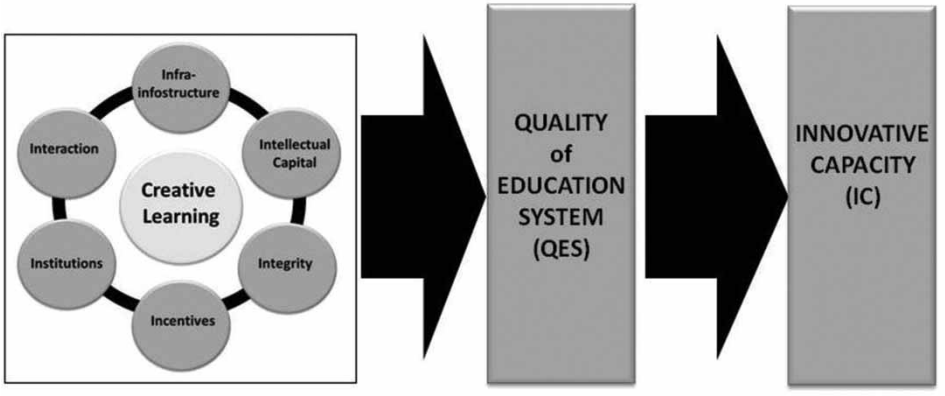

Figure 1. Relationship between CLE, QES and IC.
Source: Based on 7i HELIX model proposed by Nair (2007, 2011).

alone will not guarantee a quality education system. It requires an integrated CLE that provides a platform supporting, protecting and encouraging collaborative involvement in accessing and sharing of information in the development of new knowledge that is vital for a rapidly changing global economy.

In the section below, the CLE resources and how they contribute to a QES are discussed. While this framework is applicable to all types of education, the primary focus of this paper on higher education is because it is seen as the 'key institution in a society that is capable of mediating between the mode of knowledge, the articulation of cultural models, and institutional innovation' (Delanty 2001, 9). Furthermore it is the 'most important site for interconnectivity … in the knowledge society' (Delanty 2001, 9). As such, higher education sets the tone for education development from pre-school to post-doctoral training, including professional engagement in a society.

The first factor is the *infrastructure/infostructure* (*Infr*), facilitating a society's connectivity to the knowledge economy. The physical infrastructure such as roads, port and air transport allows the movement of people. For example, good transportation facilitates people's movement to knowledge centers and meetings with scholars and experts in the field to learn from one another. This was seen in USA, in the nineteenth century, where regions with access to waterways and transportation became centers for knowledge transfer and had a high rate of patents (Sokoloff 1988). Even today, in many developing countries, poor roads and transportation systems hinder development of human capital (Olvera, Plat, and Pochet 2003). Infostructure (that is, digital technology such as broadband) enables instantaneous connectivity, and access to and dissemination of information and knowledge. Hence, infrastructure/infostructure provides communication with international experts, and the means for transforming information into knowledge for creative endeavors (Northcott, Milliszewska, and Dakich 2007). However, in many developing countries as compared to developed countries, the provision of quality ICT infrastructure and infostructure may be lacking and this can impact the quality and stability of digital connectivity (Martinsons 2008; Datta 2011; Nair and Vaithilingam 2013).

The second CLE resource is *intellectual capital* (*Intc*), seen as an outcome of development programs where people have access to training and skills development, which include new teaching pedagogies. Vital for creativity in the competitive and fast

changing global economy (Loveless 2007), intellectual capital development enables people to keep up to date with information and knowledge, and as explained by Biggs (1999), have the capacity for higher order thinking skills, so as to use information in problem solving. A key feature for higher order thinking in a knowledge society is skills in ICT and information literacy which enable collaborative teaching and learning approaches, as well as multidisciplinary learning and research environments (Nair and Shariffadeen 2009). These are premised on higher order thinking skills and contribute to the development of the intellectual capital.

Intellectual capital development is thus intertwined with a country's infrastructure, including educational systems and institutions. Community facilities support social and intellectual capital development through people meeting, discussing and exchanging ideas (McWilliam, Dawson, and Tan 2008). Creativity is the outcome of multiple interactions in complex environments which are fostered by dynamic team environments (McWilliam, Dawson, and Tan 2008). Co-invention occurs with like-minded people connecting through shared interests and passion and via collective direction, rather than through command and control (McWilliam, Dawson, and Tan 2008). A key factor for the CLE is the stock of creative talent in the country. Leading scholars are important for fostering creative talent in others by enhancing experiential learning and practical wisdom of the new generation talent (Amabile and Khaire 2008).

The third CLE resource is *Interaction* (*Intr*) and is defined as 'smart partnerships' between all stakeholders in a knowledge driven society, such as research institutions, enterprises, industry associations, non-governmental organizations, schools and community groups (Nair 2007, 2011). Interaction is critical for knowledge and technology transfer, which is often enabled by the digital medium (McWilliam, Dawson and Tan 2008).The needs of each party in the partnership and the types of new discoveries and knowledge that are required to enhance the quality of life can be shared. For example, developing countries such as Malaysia have used foreign direct investments as a tool to attract industries, institutions of higher learning and talent from developed countries to encourage technology and knowledge transfer. The interactions have not only enhanced Malaysia's innovative capacity and competitiveness (IMD World Competitiveness Center 2012), but also positioned the Malaysian education sector as a regional hub (Global Education Digest 2012).

With the increased access to information and knowledge arising in the CLE, competition for resources, talent and markets increases, which may compromise standards of operations. This forces communities, firms and countries to address the fourth CLE resource of *integrity systems* (*Int*). Sound integrity systems encourage transparency in decision making and operations. Access to new technology also allows investors to ascertain organizations' adherence to best practices and global standards, as weak integrity systems hinder the flow of capital, talent and other resources (Danso 1995). As Cachia et al. (2010) point out in relation to education, institutions of learning and organizations that adhere to global standards tend to ensure that the education provided meets the needs of a rapidly changing economy, and that the learning environment is conducive to fostering creative learning and preparing students to meet the needs of a knowledge-intensive society.

The fifth CLE resource of *incentives* (*Inc*) is important in encouraging people to adopt new technology, and to be creative. As creativity is intertwined with problem solving (Tannenbaum 1997, cited in McFadzean 1998) and based on unconventional thinking to address vague and ill-formed issues (McFadzean 1998, citing Newell, Shaw, and Simon 1958), it requires high motivation and persistence (McFadzean

1998, citing Newell, Shaw, and Simon 1958). Incentives encourage sustained effort in the face of difficult circumstances and include fiscal and non-fiscal benefits such as productivity linked wages, research and venture capital funding (Sohn and Kenney 2007). While monetary benefits are important, systems such as research and development activities and commercialization are equally significant. A further incentive is the intensity of local competition, as it encourages higher levels of performance and achievement.

The final resource is *institutions* (*Inst*), such as the regulatory framework and standards bodies that ensure transparency and fair play in the rules of engagement. The setting of best practice benchmarks based on global standards which are addressed in the audit of institutions ensures continuous improvement. In contrast, a weak institutional framework can lead to market failures such as moral hazard, adverse selection and corrupt practices, which may lead to mismanagement of resources, hindering development (Gyimah-Brempong 2002).

In this paper, using regression models, the key relationship between the resources is examined for developed and developing countries.

Measuring CLE and its impact on quality of education and innovative capacity of nations

This study examined secondary data from *The World Economic Forum Report 2010–2011* by Schwab (2010), consisting of 113 developed, developing and under-developed countries. The key factors and their indicators are shown in Appendix 1. Each of the six factors that characterize the CLE was measured by multiple indicators, and composite scores for each of the factors were computed via the chosen indicators. The composite scores were computed using Rowe's (2006) methodology on the basis of the individual contribution of each indicator to the respective factor, as some indicators may contribute more to the measurement of the respective factors than others. This is in line with studies by Jöreskog and Sorbom (1989) that highlighted that the formation of an index by simple aggregation of the indicators based on equal weights may result in inaccurate estimation of the composite scores.

The QES of the 113 countries is also measured by multiple factors and is given in Appendix 1. The composite scores were computed in the same way as for CLE. The IC of the sample countries was measured on the basis of whether countries develop home grown technology or obtain it from other countries.

Scatter plots between CLE, QES and IC were constructed to capture the relationships between the three factors. Linear and quadratic functional forms were fitted to obtain the best fit line using the generalized least square (GLS) method. GLS was used to correct for heteroskedasticity using the White's method. Based on the scatter plots, pace-setter countries with strong CLE and high QES and IC were identified. The country codes in the scatter plots are provided in Appendix 2. Using this benchmarking analysis, the level of a country's CLE can be identified in relation to its QES and IC; as well as the relationship of QES to IC.

Results

The relationships between CLE, QES and IC are discussed in this section, and the scatter plot for CLE and QES is given in Figure 2. This shows that the quadratic model is the best fit regression model to capture the relationship between CLE and

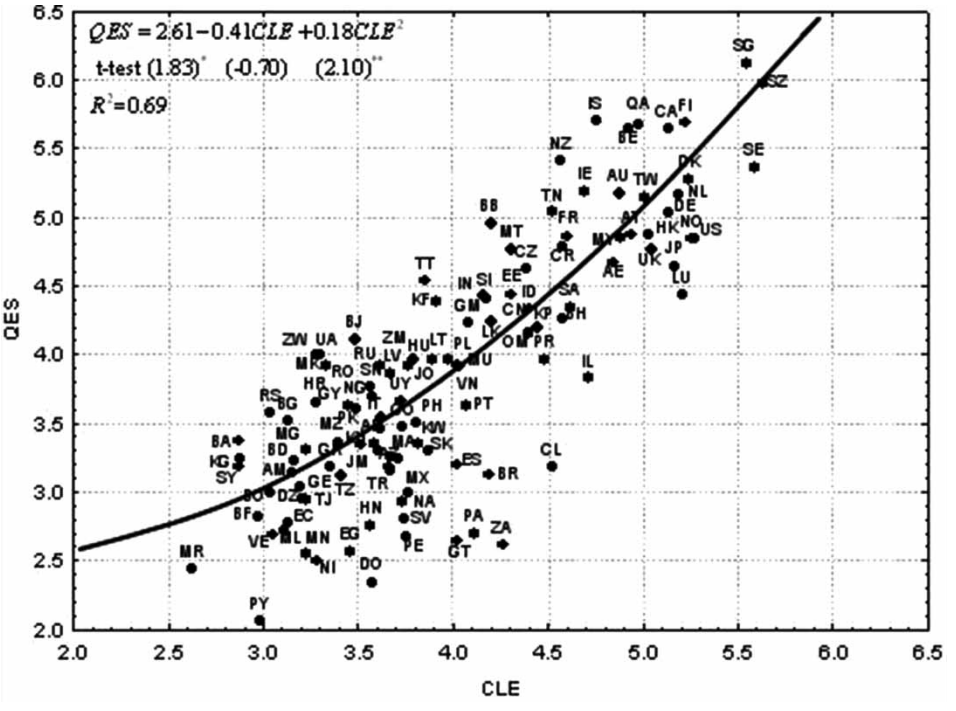

Figure 2. Relationship between CLE and QES. The 1%, 5% and 10% significance levels are denoted as ***, ** and *, respectively.

QES. This regression equation implies that improvements in CLE will lead to accelerated increase in QES. The model shows that 69% of the QES variation can be explained by the CLE variation. Pace-setter countries based on this scatter plot are Switzerland (SZ), Singapore (SG), Sweden (SE) and Finland (Fl). Most advanced countries are in the top 20%, and the scatter plot also shows that most under-developed countries have weak CLE and poor QES.

The relationship between CLE and IC is given in Figure 3. In this case also, the quadratic regression model was the best fit line, with close to 74% of the variation in CLE explaining the variation in IC. The pace-setter countries based on this scatter plot are as follows: Switzerland (SZ), Sweden (SE), Germany (DE), Japan (JP), Finland(Fl) and USA (US). Similar to the earlier scatter plot, most advanced countries are in the upper quadrant, while under-developed countries are at the lower end of the scatter plot. Interestingly, also present in these top percentages are some developing countries such as Malaysia (MY) and Qatar (QA), indicating that developing countries are now implementing measures that will lead to creative thinking and innovation, thus increasing national prosperity.

The relationship between QES and IC is shown in Figure 4. The scatter plot shows that countries with high QES are also high on IC. In this case, the linear regression model was the best fit model for this scatter plot, where 53% of the variation in IC is explained by the variation in QES. The pace setter countries based on this scatter plot are Switzerland, Finland, Sweden, Belgium (BE) and Singapore. The empirical analysis also shows that countries with low QES are also low in IC.

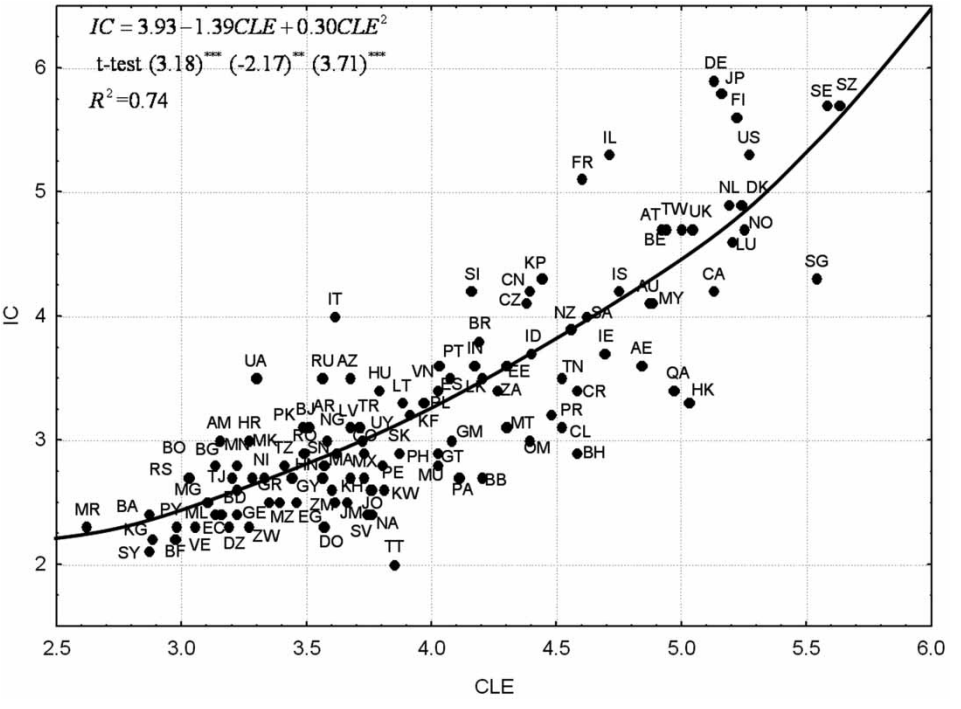

Figure 3. Relationship between CLE and IC. The 1%, 5% and 10% significance levels are denoted as ***, ** and *, respectively.

The empirical analysis reveals that there are associations between stages of development of CLE, QES and IC. Countries that score highly on CLE also score highly on QES and IC, and the converse is also evident. Countries ranked in the lowest percentages and classified as impoverished with little or no CLE include Mauritania (MR), Paraguay (PY) and Syria (SY), and remain in the clutches of poverty. In countries such as these, basic facilities for tertiary education are not in place and there is serious brain-drain, depleting the vital human resources that ensure sustained economic development (Haque and Kim 1994). Lack of a talented workforce in laggard countries hinders their ability to use their natural resources optimally and improve their socioeconomic wellbeing (Hagopian and Lee 2012).

In relation to the global financial crisis of 2009 and subsequent difficulties of a few European economies, it is interesting that Portugal (PT), Italy (IT), Greece (GR) and Spain (ES) are middle to lower ranking countries, scoring moderately on the CLE, QES and IC. Their loss of competitiveness and economic woes in recent years perhaps can be attributed to weaknesses in the CLE relative to other emerging economies such as Korea (KP), Hong Kong (HK), Malaysia (MY) and Taiwan (TW).

As evident in the scatter charts in Figures 2–4, the QES is important in this investigation, and this study has previously explained the pivotal role of the higher education sector for fostering creativity across the broader education system. In the next section, key features of pace-setter countries' higher education systems that have facilitated their movement up the innovation value chain will be highlighted. Here, the paper will discuss the case studies from Switzerland, Singapore and Finland.

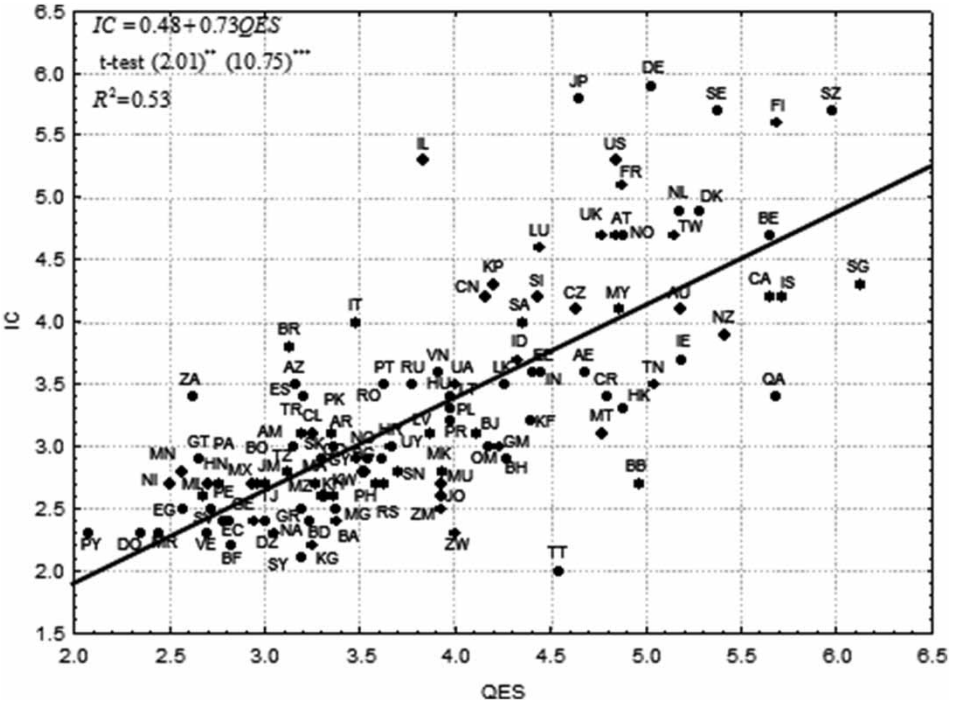

Figure 4. Relationship between QES and IC. The 1%, 5% and 10% significance levels are denoted as ***, ** and *, respectively.

Discussion: case studies from selected pace-setter countries

Based on the empirical analysis shown above, Switzerland emerged as the lead country with a high quality education environment that nurtures creativity and enhances innovative capacity. The holistic development of Switzerland's CLE has enabled it to be one of the most competitive countries globally. The move of the Swiss CLE up the global innovation value chain was led by the Swiss quality assurance body called the Swiss University Conference (SUC), which provides oversight for quality assurance and certification of all Swiss institutions of higher learning (IHL). The primary role of SUC is to ensure that the education provided by IHLs has diversity in choice, incorporates state-of-the-art learning environments and research-led curricula and has exposure to international knowledge networks (Kleiber and Renold 2006).

Many of the learning institutions in Switzerland also include technology transfer offices to promote transnational interaction and knowledge exchange between universities and industry (Kleiber and Renold 2006). Switzerland has also fostered an environment that values science, technology, higher education and innovation, as seen in its establishment of outposts such as that located in Boston (Fetscherin and Marmier 2010). To support and protect individuals and organizations' creative endeavors, a dynamic intellectual property (IP) regulatory environment was established (Kleiber and Renold 2006). The creative learning environment which is focused on a research-led curriculum encourages higher order thinking, which underpins creativity and innovation, as explained previously.

Singapore scored well in the development of CLE, QES and IC. Overall, its higher education system emphasizes practical integration and interdisciplinarity, 'encouraging an entrepreneurial spirit among students' (Mok 2011, 67).The press release from Ministry of Education, Singapore (2010), asserts the maturity and 'cutting edge' nature of the higher education system. Since independence in 1958, emphasis has been placed on developing infrastructure, and Singapore's telecommunication infrastructure in the early 1990s was seen as the best in the world (Spar 2009, 23). Effective institutions to address corruption, and in more recent times, the establishment of private higher education systems, have stimulated competition in the public system (Mok 2011). Further, postgraduate education and research have been a focus since the late 1980s, and creativity in thinking has been encouraged in undergraduate curriculum, along with cross disciplinary research and learning (Mok 2011). A strong quality assurance system is in place for the private higher education institutions, and joint degree programs operate between local and overseas partners, as well as 'active collaboration with peer institutions across the world' (Mok 2011, 66).

Another small country that has gained global economic competitiveness over the last decade is Finland, and much can be attributed to its successful development of CLE. The Organization for Economic Co-operation and Development (OECD) report (Davies et al. 2009) for higher education in Finland emphasizes the economic importance of the key roles of higher education and research and development. The report indicates the country's mature CLE, as evidenced in the infrastructure, and government funding and incentives which include initiatives for universities, and the widespread public support to maintain high quality research and development. Evidence of interaction is the penetration of the creative ecosystem to the point that industry demands innovation, and media pays attention to the issue. The country's approach to educators indicates its strong commitment to education: teachers at all levels of the system have high salaries and high social prestige (Sahlberg 2011). In Finnish universities, future teachers are exposed to subject focused pedagogical approaches and research, co-operative and problem based learning, reflective practice and computer supported education (Sahlberg 2011).

The OECD report (Davies et al. 2009) further points to the integration of the CLE in the country, as Finns are aware of their strong dependence on their small labor force, and sustainable development of the economy can only be based on a CLE that encourages continuous learning and innovation. In the spirit of continuous improvement, Finnish higher education is gauged as requiring a more entrepreneurial ethos through funding diversification. This report explains that large increases in student mobility both in and out of the country have been developed, and explicit research benchmarking has been undertaken against other European countries so as to widen scope and quality (Davies et al. 2009).

Conclusion

The capacity for society members to engage in creative thinking and innovation is integral to the knowledge society and vital for nations' competitiveness and sustainable development. Creative thinking is the engine and accelerator for innovation and is the hallmark of a quality education system in today's world. A quality education system is shaped by a number of societal factors as seen in the CLE outlined in this study, where the resources operate together, to form an ecosystem.

This study supports the view that while societies are at different stages of economic development, so too correspondingly are their CLEs, their QES and IC. While all education sectors have an important role in a knowledge economy, the quality of the higher education system acts as a catalyst for developing and nurturing creativity from preschool to post-doctoral centers. By reviewing countries that have performed highly, such as Switzerland, Singapore and Finland, this study identifies best practices of their higher education systems. These can function as guidelines for countries that wish to improve the quality of the education, for creativity and innovation.

This study finds that the education system for a knowledge economy needs to ensure that people have the necessary infrastructure/infostructure to access high quality education. Further, they should enhance intellectual capacity through emphasis on active learning as seen in research, international links and problem solving, and knowledge transfer with other leading educational centers of excellence. Also required are smart partnerships with key stakeholders within the country and across the globe to enrich learning. The empirical analysis and case studies from the pace-setter countries show that strong integrity and governance systems are important for ensuring quality and, thus the standards of an education system. A key feature of a sound governance system is to ensure that there is adequate provision of incentives to foster creative learning and innovation.

For institutions and individual staff within them, the implications are that educational directions need to go beyond the subject content and the local setting. At appropriate levels according to the institution's degree of development, focus needs to be on active and applied learning, outside the classroom and away from the text book. These are approaches that need to be encouraged, supported and rewarded at the institutional and individual staff member levels.

In summary, the global society is changing rapidly and societies that are leading in the development of a creative learning ecosystem are also leading in quality education systems and innovation. Countries that do not invest in developing the resources of a creative learning ecosystem risk falling behind in innovation and competitiveness. Within this framework, further research could explore the relationships of individual factors of the CLE with QES and IC.

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Appendix 1. Data description

Blueprints		Variable	Description	Measures
Infra-infostructure (*Infr*)	$I_{1,1}$	Quality of roads	How would you assess roads in your country?	1= extremely under-developed; 7 = extensive and efficient to international standards.
	$I_{1,2}$	Quality of port infrastructure	How would you assess port facilities in your country?	1= extremely under-developed; 7 = extensive and efficient to international standards.
	$I_{1,3}$	Quality of air transport infrastructure	How would you assess passenger air transport infrastructure in your country?	1= extremely under-developed; 7 = extensive and efficient to international standards.
	$I_{1,4}$	Broadband Internet subscribers	Number of fixed broadband Internet subscriptions per 100 population 2009	Rescaled.
Intellectual capital development (Intc)	$I_{2,1}$	Internet access in schools	How would you rate the level of access to the Internet in schools in your country?	1 = very limited; 7 = extensive.
	$I_{2,2}$	Local availability of specialized research and training services	In your country, to what extent are high-quality, specialized training services available?	1 = not available; 7 = widely available.
	$I_{2,3}$	Extent of staff training	To what extent do companies in your country invest in training and employee development?	1 = hardly at all; 7 = to a great extent.
	$I_{2,4}$	Brain drain	Your country's talented people	1 = normally leave to pursue opportunities in other countries, 7 = almost always remain in the country.
Interaction (Intr)	$I_{3,1}$	Cooperation in labor–employer relations	How would you characterize labor–employer relations in your country?	1 = generally confrontational; 7 = generally cooperative.
	$I_{3,2}$	FDI and technology transfer	To what extent does foreign direct investment (FDI) bring new technology into your country?	1 = not at all; 7 = key source of new technology.
	$I_{3,3}$	University–industry collaboration in R&D	To what extent do business and universities collaborate on research and development (R&D) in your country?	1 = do not collaborate at all; 7= collaborate extensively.

(*Continued*.)

Appendix 1. (*Continued*.)

Blueprints		Variable	Description	Measures
	$I_{3,4}$	State of cluster development	In your country's economy, how prevalent are well-developed and deep clusters?	1 = nonexistent; 7 = widespread in many fields.
Integrity (Int)	$I_{4,1}$	Diversion of public funds	In your country, how common is diversion of public funds to companies, individuals, or groups due to corruption?	1 = very common; 7 = never.
	$I_{4,5}$	Transparency of government policymaking	How easy is it for businesses in your country to obtain information about changes in government policies and regulations affecting their activities?	1 = impossible; 7 = extremely easy.
	$I_{4,8}$	Ethical behavior of firms	How would you compare the corporate ethics (ethical behavior in interactions with public officials, politicians, and other enterprises) of firms in your country with those of other countries in the world?	1 = among the worst in the world; 7 = among the best in the world.
Incentives (Inc)	$I_{5,1}$	Intensity of local competition	How would you assess the intensity of competition in the local markets in your country?	1 = limited in most industries; 7 = intense in most industries.
	$I_{5,8}$	Pay and productivity	To what extent is pay in your country related to productivity?	1 = not related to productivity; 7 = strongly related to productivity.
	$I_{5,12}$	Company spending on R&D	To what extent do companies in your country spend on R&D?	1 = do not spend; 7 = spend heavily.
	$I_{5,11}$	Venture capital available	In your country, how easy is it for entrepreneurs with innovative but risky projects to find venture capital?	1 = very difficult; 7 = very easy
Institutions (Inst)	$I_{6,1}$	Property rights	How would you rate the protection of property rights, including financial assets, in your country?	1 = very weak; 7 = very strong.
	$I_{6,2}$	Intellectual property protection	How would you rate intellectual property protection, including anti-counterfeiting measures, in your country?	1 = very weak; 7 = very strong.
	$I_{6,5}$	Efficiency of legal framework in settling disputes	How efficient is the legal framework in your country for private businesses in settling disputes?	1 = extremely inefficient; 7 = highly efficient.

(*Continued*.)

Appendix 1. (*Continued*.)

Blueprints		Variable	Description	Measures
	$I_{6,7}$	Strength of auditing and reporting standards	In your country, how would you assess financial auditing and reporting standards regarding company financial performance?	1 = extremely weak; 7 = extremely strong.
Quality of education systems (QES)	*Y*	Quality of the educational system	How well does the educational system in your country meet the needs of a competitive economy?	1= not well; 7 = very well.
		Quality of math and science education	How would you assess the quality of math and science education in your country's schools?	1 = poor; 7 = excellent – among the best in the world.
		Quality of scientific research institutions	How would you assess the quality of scientific research institutions in your country?	1 = very poor; 7 = the best in their field internationally.
Innovative capacity (IC)	*Z*	Capacity for Innovation	In your country, how do companies obtain technology?	1 = exclusively from licensing or imitating foreign companies; 7 = by conducting formal and pioneering their own new products and processes.

Notes: The data were obtained from Schwab (2010). Respondents indicated the extent of their agreement or disagreement with statements on a seven-point Likert scale (1 = 'strongly disagree', 7 = 'strongly agree'). Where hard data were used to represent the indicators, they were rescaled to a 7-point Likert scale for consistency. For the rescaling of the hard data to a seven-point Likert scale, the following formula was used: Re-scaled index = $7 - \frac{6(\textit{maximum value} - \textit{orignal data})}{\textit{maximum value}}$

Appendix 2. Country code for the 113 countries

Country	Abbre-viation	Country	Abbre-viation	Country	Abbre-viation	Country	Abbre-viation	Country	Abbre-viation
Algeria	DZ	Czech Republic	CZ	Italy	IT	Netherlands	NL	South Africa	ZA
Argentina	AR	Denmark	DK	Jamaica	JM	New Zealand	NZ	Spain	ES
Armenia	AM	Dominican Republic	DO	Japan	JP	Nicaragua	NI	Sri Lanka	LK
Australia	AU	Ecuador	EC	Jordan	JO	Nigeria	NG	Sweden	SE
Austria	AT	Egypt	EG	Kenya	KF	Norway	NO	Switzerland	SZ
Azerbaijan	AZ	El Salvador	SV	Korea	KP	Oman	OM	Syria	SY
Bahrain	BH	Estonia	EE	Kuwait	KW	Pakistan	PK	Taiwan	TW
Bangladesh	BD	Finland	FI	Kyrgyz Republic	KG	Panama	PA	Tajikistan	TJ
Barbados	BB	France	FR	Latvia	LV	Paraguay	PY	Tanzania	TZ
Belgium	BE	Gambia	GM	Lithuania	LT	Peru	PE	Trinidad and Tobago	TT
Benin	BJ	Georgia	GE	Luxembourg	LU	Philippines	PH	Tunisia	TN
Bolivia	BO	Germany	DE	Macedonia	MK	Poland	PL	Turkey	TR
Bosnia and Herzegovina	BA	Greece	GR	Madagascar	MG	Portugal	PT	Ukraine	UA
Brazil	BR	Guatemala	GT	Malaysia	MY	Puerto Rico	PR	United Arab Emirates	AE
Bulgaria	BG	Guyana	GY	Mali	ML	Qatar	QA	United Kingdom Kingdom	UK
Burkina Faso	BF	Honduras	HN	Malta	MT	Romania	RO	United States	US
Cambodia	KH	Hong Kong SAR	HK	Mauritania	MR	Russian Federation	RU	Uruguay	UY
Canada	CA	Hungary	HU	Mauritius	MU	Saudi Arabia	SA	Venezuela	VE
Chile	CL	Iceland	IS	Mexico	MX	Senegal	SN	Vietnam	VN
China	CN	India	IN	Mongolia	MN	Serbia	RS	Zambia	ZM
Colombia	CO	Indonesia	ID	Morocco	MA	Singapore	SG	Zimbabwe	ZW
Costa Rica	CR	Ireland	IE	Mozambique	MZ	Slovak Republic	SK		
Croatia	HR	Israel	IL	Namibia	NA	Slovenia	SI		